Passive Technology to Improve Criticality Control of NTP Reactors, Phase II

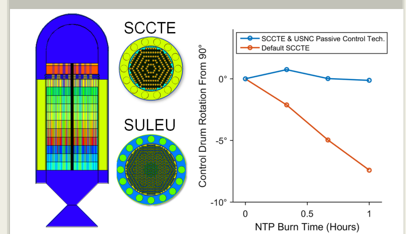
Completed Technology Project (2016 - 2019)

Project Introduction

This SBIR will develop passive reactor criticality control technology for Nuclear Thermal Propulsion (NTP) identified by Ultra Safe Nuclear Corporation (USNC) in Phase 1. This technology will allow NTP systems to start up by rotating the control drums to a single predetermined location and remain there for the duration of operation for the majority of the burns associated with a Mars mission. Passive technology will greatly simplify the control of NTP systems and increase their overall performance during operation. USNC's passive criticality control technology works by -Employing advanced burnable neutron poison to completely remove the need for control drum movement during a full power burn. -Tuning the hydrogen density in the tie-tubes to ensure a consistent start-up position for the control drums. -Enhancing the fuel temperature reactivity feedback mechanism to ensure the stability of the reactor and reduce the burden for active control. This work addresses noted research needs so that NTP systems can help enable human exploration to Mars and other destinations. USNC's Phase 2 work will be a substantial improvement over the state-of-the-art and increase the overall knowledge of NTP control. At the end of Phase 2 USNC will: -Produce a NTP transient code (named the "TRICORDER" code) capable of modeling NTP systems through start up to the end of a burn. -Develop passive criticality control technology rigorously with TRICORDER -Design and then fabricate a new NTP burnable neutron poison (named the "BORGalloy" alloy) and test it in prototypic NTP environments. -Deliver NTP LEU Cermet, LEU Graphite Composite, and HEU Graphite Composite NTP system designs that showcase passive criticality control for human Mars missions.

Anticipated Benefits

NTP has great promise in spreading human presence to Mars and other locations beyond low earth orbit. USNC's passive criticality control technology will address key needs in NTP development to make it a viable technology to fulfill NASA human exploration needs. USNC's work directly aligns with the NASA Technological Roadmap 2015 which calls for complex reactor models to optimize the nuclear thermal propulsion (NTP) engine systems. Currently, NTP and USNC's passive criticality control technology is being investigated for a human Mars mission in the 2030s time frame, but NTP also has application for longer term goals such as exploration beyond Mars and aiding in Space colonization. In the near term, USNC's technology will be able to support NTP development efforts by providing the research tools needed to address NTP related questions (TRICORDER) and give assurance that private industry can address key technology needs for NTP systems (BORGalloy, and HYPOSPRA). TRICORDER will be able to provide the highest fidelity modeling of the NTP system to date and will be a valuable research tool for developing NTP systems. Beyond NTP, the technology and expertise that USNC is building has application to small nuclear systems for surface power and science missions. Small nuclear systems are a very appealing technology for space exploration



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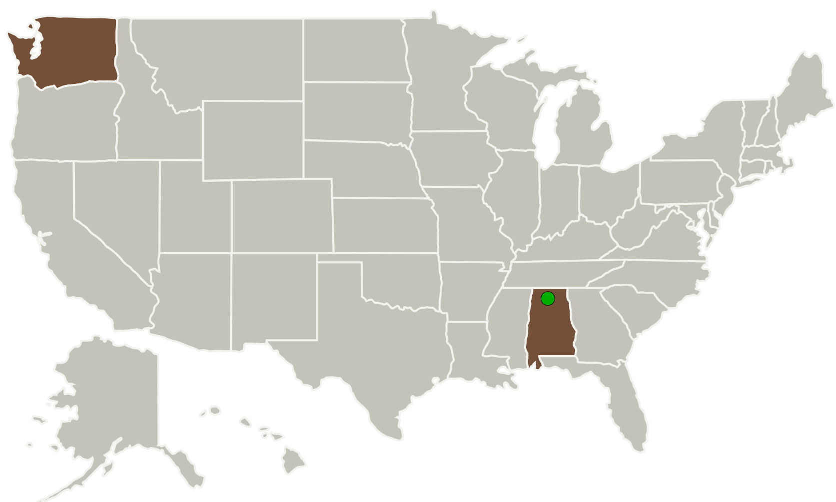
because they can provide power independent of solar availability and for extended periods of time.There is an emerging market need for advanced reactors that provide power in locations and markets where traditional nuclear power plants cannot be utilized effectively. There are approximately 40 U.S. companies trying to bring advanced nuclear technology to the marked backed by a total of more than 1.3 billion dollars of private investment. USNC's passive reactivity control technology can address the needs of this emerging market. Specifically, our passive reactivity control technology can minimize the operator burden for controlling these new advanced reactors and as a result make the reactors safer and more profitable. As mentioned in the above section, USNC is pursuing this emerging market and actively developing small, passively safe, and long-lived nuclear power reactors that can be operated in remote locations. The technology and expertise developed in this SBIR can be directly applied to USNC's small reactor development efforts

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Ultra Safe Nuclear Corporation	Lead Organization	Industry	Seattle, Washington
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Ultra Safe Nuclear Corporation

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Project Managers:

Bill Emrich
Gwenevere L Jasper

Principal Investigator:

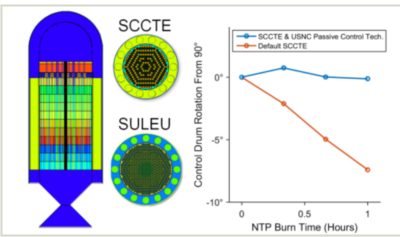
Paolo F Venneri

Co-Investigator:

Paolo Venneri

Primary U.S. Work Locations	
Alabama	Washington

Images



Briefing Chart Image
Passive Technology to Improve Criticality Control of NTP Reactors, Phase II
(https://techport.nasa.gov/image/135413)

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**

1 2 3 4 5 6 7 8 9

Applied Research | Development | Demo & Test

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System